PATENT SPECIFICATION 583,963

Application Date: Aug. 9, 1944. No. 15174/44.

Complete Specification Left: Sept. 25, 1945.

Complete Specification Accepted: Jan. 3, 1947.

PROVISIONAL SPECIFICATION

Improvements in Aircraft Landing Gear

We, MILES AIRCRAFT LIMITED, a British Company, of The Aerodrome, Reading, Berkshire, and JOHN WHITAKER WOODHOUSE, a British Subject, of the Company's address, do hereby declare the nature of this invention to be as follows:—

Although applicable to aircraft landing gear generally, the invention is particularly concerned with the construction of aircraft tailwheel mounting units, the chief object being to evolve a unit of simple construction utilising natural or synthetic rubber as the shock-absorbing medium in lieu of hydraulic or other fluids now fairly generally employed, the unit by virtue of its simple construction being cheap and easy to manufacture and being light in weight, the unit necessitating a minimum of maintenance when in service.

The invention consists broadly in incorporating in aircraft landing gear a shock-absorber unit the shock-absorbing medium of which is natural rubber, synthetic rubber or similar elastic material operating in torsion, the shock-absorber unit comprising a non-circular outer member and a non-circular inner member disposed within said outer member in spaced relationship, said inner and outer members carrying between them an intervening layer of natural rubber, synthetic rubber, or similar elastic material which will permit of a constrained relative rotational movement between the inner and outer members, the members by virtue of the elastic properties of the rubber or similar material tending always to return to their initial relative positions. It will be appreciated that owing to the non-circular formation of the inner and outer members although the rubber or like material will in the main be subjected to torsional stresses, the material will also be subjected to compression and tension when in use, this being not only due to the non-circular formation of the inner and outer members, but also due to the radial forces applied to the rubber or like material as a result of the wheel loads.

Although it is within the scope of the present invention to utilise an intervening rubber or like layer which is not actually united to the inner and/or outer members, it is preferred that it shall be secured in position to both inner and outer members by any suitable or known method of rubber-to-metal bonding process, for example that known in the trade as the Metalastik process. It is convenient to construct such a shock-absorber in the form of a unit, the unit comprising an inner metal member, an outer relatively thin metal member, and an intervening layer of rubber or like material, the rubber or like material being bonded to the inner member and to the thin metal outer member which virtually constitutes a housing. It is preferred, furthermore, that the thin metal housing shall be split at one or more points to permit of the unit being compressed slightly to enable it to be inserted in a slightly compressed state within a conveniently-shaped opening provided in the member with which the unit is to be used.

Although the inner and outer members may be of any suitable non-circular cross-sectional shape desired, it is preferred that one part, and preferably both parts, shall be of elliptical form, or substantially elliptical form, in side elevation, it being desirable that both inner and outer members shall be free from sharp angles or corners which might result in the rubber or like material being non-uniformly stressed under torsional loads. As in use it is likely that in certain circumtances, for example in the case of the shock-absorber being associated with a tailwheel mounting unit or main landing wheel undercarriage leg or strut, the rubber or like material will be subjected to radially-arranged loads in addition to torsional loads, it is preferred that that part of the rubber or like material which may be called upon to take a radial load in addition to a torsional load shall be of greater thickness than the remainder. For example, the rubber or like material may be thicker intermediate the extremities of the inner and outer members, this being the case in the application of the shock-absorber unit to a tailwheel mounting unit in which the common major axes of the elliptical inner and outer members are dis-

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posed substantially at right-angles to the centre-line of a wheel fork arranged in trail.

Although it is within the scope of the present invention to arrange for both inner and outer members to be capable of rotational movement in opposite directions, or for the outer member to be moved angularly relative to the inner member, it is usually convenient for the outer member to be fixed in relation to the structure with which it is associated and for the inner member to be arranged for angular movement relative to the fixed outer member, the inner member in the case of the application of the shock-absorber unit to a tailwheel mounting or main undercarriage leg being capable of angular movement relative to the fixed outer member under a fluctuating wheel load.

The invention will first be described in detail as applied to an aircraft tailwheel mounting unit, the shock-absorber unit being located in position within an appropriately-shaped mounting bracket adapted for attachment to the airframe through the medium of an upstanding leg, the latter being adapted to be rotatably mounted in position upon the airframe and being fitted if desired with rollers for engagement with a self-centering cam.

The mounting bracket may be of any suitable shape and is conveniently of elliptical or streamline form, the shock-absorber unit being pressed into position within a suitably-dimensioned hole provided for its reception in the bracket, the major axis of the elliptical shock-absorber unit being as hereinbefore mentioned disposed at right-angles or substantially at right-angles to a trailing wheel fork or like wheel-carrying member.

The wheel fork preferably comprises two spaced wheel-carrying members which are bolted on opposite sides of the inner member of the shock-absorber unit, the latter being bored with two spaced holes for the reception of bolts which serve to secure the fork parts in position on opposite sides of the inner member in their correct spaced relationship. In this connection it is preferred that the inner member shall be of slightly greater length than the outer member and its associated mounting bracket so that the wheel fork parts are well clear of the edges of the mounting bracket and outer member, even when the tailwheel is subjected to side loads applied axially of the shock-absorber unit. It will be appreciated, therefore, that with the wheel fork inclined rearwardly and downwardly in trail, the rubber or like material intermediate the ends of the elliptical-shaped inner and outer members will be subjected to compression and tension stresses, and for that reason it is preferred that the rubber or like material shall be of an increased thickness at those points.

It will be appreciated that varying wheel loads applied to the tailwheel during landing or take-off, or when taxying, will result in angular movement of the wheel fork and inner member relatively to the outer member and its associated mounting bracket, the intervening layer of rubber or like material being thus subjected to torsion. In addition, the rubber or like material will as hereinbefore stated be subjected to compression and tension stresses owing to the direction of the wheel loads and the fact that the inner and outer members are of non-circular cross-sectional shape.

As applied to a main undercarriage strut where the wheel loads will be considerably higher than those to which the shock-absorber would be likely to be subjected when used in conjunction with a tailwheel mounting, it is preferred that a plurality of such shock-absorber units shall be employed which may be connected together in any suitable manner so that they will be capable of absorbing the higher wheel loads encountered.

In one exemplification the main landing wheel may be mounted between fork members which also are preferably arranged in trail, the fork members being bolted or otherwise secured at a point intermediate their length to the inner member, or inner members, of the shock-absorber unit or units, the shock-absorber units, if more than one is employed, being mounted coaxially, the forwardly-projecting ends of the fork members being connected by a suitable link or links with one or more additional shock-absorber units carried by the strut or, alternatively, its mounting bracket. The additional unit or units may, for example, be carried by the usual mounting bracket into which the upper end of the undercarriage strut fits, the inner member, or inner members if more than one unit is employed, being fitted with one or more lever arms which are pivotally attached to the upper end or ends of the link or links. With this arrangement pivotal movement of the wheel fork parts as a result of a fluctuating wheel load will result in torsional stresses being set up in all the shock-absorber units, angular movement of the wheel fork parts being transmitted by way of the intervening link or links to the lever arm or arms associated with the upper shock-absorber unit or units. For the purpose of accurate adjustment of the two sets of shock-absorber units separated by the intervening link or links, the latter

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may be adjustable in length. Furthermore, it will be appreciated that in such a case the major axis of each shock-absorber unit may be arranged horizontal or substantially horizontal and for that reason it may be found desirable, instead of increasing the thickness of the rubber or like material intermediate the extremities of the inner and outer members, to increase the thickness of the rubber at the sides of the inner and outer members.

Although it is preferred that the rubber shall be bonded to the inner and outer members, the rubber might for example be inserted under tension, the rubber after insertion being permitted to expand so as to grip the surfaces of the inner and outer metal members.

Dated this 9th day of August, 1944.

For the Applicants:
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COMPLETE SPECIFICATION

Improvements in Aircraft Landing Gear

We, MILES AIRCRAFT LIMITED, a British Company, of The Aerodrome, Reading, Berkshire, and JOHN WHITAKER WOODHOUSE, a British Subject, of the Company's address, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Although applicable to aircraft landing gear generally, the invention is particularly concerned with the construction of aircraft tailwheel mounting units, the chief object being to evolve a unit of simple construction utilising natural or synthetic rubber as the shock-absorbing medium in lieu of hydraulic or other fluids now fairly generally employed, the unit by virtue of its simple construction being cheap and easy to manufacture and being light in weight, the unit necessitating a minimum of maintenance when in service.

The invention consists broadly in aircraft landing gear incorporating a torsion unit or a shock-absorbing unit comprising two members connected by an intervening layer of elastic material, which layer is deformable under the landing load and thereby permits of relative movements of partial rotation between the two said members. It may be pointed out that as contrasted with the hydraulic or other fluid shock absorbers commonly employed in aircraft landing gear, the selection of the foregoing torsion unit or shock-absorbing unit for employment in aircraft landing gear permits of a striking reduction in the complexity, initial cost, weight, and servicing of such gear. In the preferred construction of landing gear the two said members of the unit comprise an outer member and an inner member housed therein and the elastic member encircles the inner member within the outer member. The invention further includes aircraft landing gear incorporating a torsion unit or shock-absorbing unit comprising inner and outer members having respectively outer and inner peripheries of non-circular form, and an intervening layer of elastic material. The aforesaid intervening layer is of natural rubber, synthetic rubber, or similar elastic material, which will permit of a constrained relative rotational movement between the inner and outer members, the members by virtue of the elastic properties of the rubber or similar material tending always to return to their initial relative positions. It will be appreciated that owing to the non-circular formation of the inner and outer members although the rubber or like material will in the main be subjected to torsional stresses, the material will also be subjected to compression and tension when in use, this being not only due to the non-circular formation of the inner and outer members, but also due to the radial forces applied to the rubber or like material as a result of the wheel loads.

Although it is within the scope of the present invention to utilise an intervening rubber or like layer which is not actually united to the inner and/or outer members, it is preferred that it shall be secured in position to both inner and outer members by any suitable or known method of rubber-to-metal bonding process, for example that known in the trade as the Metalastik process. It is convenient to construct such a shock-absorber in the form of a unit, the unit comprising an inner metal member, an outer relatively thin metal member, and an intervening layer of rubber or like material, the rubber or like material being bonded to the inner member and to the thin metal outer member which virtually constitutes a housing. It is preferred, furthermore, that the thin metal housing shall be split at one or more points to permit of the unit being compressed slightly to enable it to

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be inserted in a slightly compressed state within a conveniently-shaped opening provided in the member with which the unit is to be used.

Although the inner and outer members may be of any suitable non-circular cross-sectional shape desired, it is preferred that one part, and preferably both parts, shall be of oval or elliptical form, or substantially oval or elliptical form, in side elevation, it being desirable that both inner and outer members shall be free from sharp angles or corners which might result in the rubber or like material being non-uniformly stressed under torsional loads. As in use it is likely that in certain circumstances, for example in the case of the shock-absorber being associated with a tailwheel mounting unit or main landing wheel undercarriage leg or strut, the rubber or like material will be subjected to radially-arranged loads in addition to torsional loads, it is preferred that that part of the rubber or like material which may be called upon to take a radial load in addition to a torsional load shall be of greater thickness than the remainder. For example, the rubber or like material may be thicker intermediate the extremities of the inner and outer members, this being the case in the application of the shock-absorber unit to a tailwheel mounting unit in which the common major axes of the elliptical inner and outer members are disposed substantially at right angles to the centre-line of a wheel fork arranged in trail. In the foregoing connection it is to be acknowledged that a proposal has been made in Patent Specification No. 493,521 (to which reference is directed for further particulars) for a resilient mounting or connection comprising an outer metallic member having an internal space of elliptical cross-sectional form in at least one plane, which space surrounds a second metallic member of elliptical cross-sectional external form in at least one plane, in such a way as to produce a completely closed elliptical annular space of approximately uniform cross-section, the annular space being filled with rubber or the like resilient material adhesively secured both to the inner wall of the elliptical hollow space of the outer member and to the periphery of the elliptical inner member, and a rigid lever rigidly secured to or integral with one of the aforesaid metallic members for transmitting oscillations, whereby on relative rotary displacement of said metallic members the rubber or the like is subjected to compression, tension and shearing stresses.

Although it is within the scope of the present invention to arrange for both inner and outer members to be capable of rotational movement in opposite directions, or for the outer member to be moved angularly relative to the inner member, it is usually convenient for the outer member to be fixed in relation to the structure with which it is associated and for the inner member to be arranged for angular movement relative to the fixed outer member, the inner member in the case of the application of the shock-absorber unit to a tailwheel mounting or main undercarriage leg being capable of angular movement relative to the fixed outer member under a fluctuating wheel load.

The foregoing and other features of the invention set out in the appended claims are incorporated in the various constructions on aircraft landing gear which will now be described with reference to the accompanying drawings in which:—

Figure 1 is a side elevation of a tail wheel mounting unit according to this invention.

Figures 2 and 3 are respectively an end elevation of and a longitudinal section through the shock absorber unit employed in landing gear according to this invention;

Figures 4 and 5 are side elevations of two main undercarriage units according to this invention,

The invention will first be described in detail with reference to Figs. 1—3, as applied to an aircraft tailwheel mounting unit wherein the shock absorber unit 1 is located in position within an appropriately-shaped mounting bracket 2 arranged for attachment to the airframe through the medium of an upstanding leg 3. The latter is arranged to be rotatably mounted in position upon the airframe and being fitted if desired with rollers 4 for engagement with a self-centering cam 5. Alternatively, of course, the cam 5 may be on the leg 3 and the rollers 4 on the airframe; Fig. 1 may be interpreted as showing either arrangement.

The mounting bracket 2 may be of any suitable shape and is conveniently of elliptical or streamline form, the shock-absorber unit 1 being pressed into position within a suitably-dimensioned hole provided for its reception in the bracket 2, the major axis of the elliptical shock-absorber unit being as hereinbefore mentioned disposed at right-angles or substantially at right-angles to a trailing wheel fork or like wheel-carrying castor-member 6.

The wheel fork preferably comprises two spaced wheel-carrying members 6 which are bolted on opposite sides of the inner member 1a of the shock-absorber unit 1, the latter being bored with two spaced holes 7 for the reception of bolts 8 which

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serve to secure the fork parts in position on opposite sides of the inner member in their correct spaced relationship. In this connection it is preferred that the inner member 1*a* shall be of slightly greater length than the outer member or shell 1*b* (as shown in Fig. 3) and its associated mounting bracket 2 so that the wheel fork parts 6 are well clear of the edges of the mounting bracket 2 and outer member 1*b*, even when the tailwheel 9 is subjected to side loads applied axially of the shock-absorber unit. It will be appreciated, therefore, that with the wheel fork inclined rearwardly and downwardly in trail, the rubber or like material 1*c* intermediate the ends of the elliptical-shaped inner and outer members 1*a*, 1*b* will be subjected to compression and tension stresses, and for that reason it is preferred that the rubber or like material shall be of an increased thickness at those points. The before-mentioned splits in the thin metal outer shell or housing are indicated at 10.

It will be appreciated that varying wheel loads applied to the tailwheel during landing or take-off or when taxying, will result in angular movement of the wheel fork 6 and inner member 1*a* relatively to the outer member 1*b* and its associated mounting bracket 2, the intervening layer of rubber or like material 1*c* being thus subjected to torsion. In addition, the rubber or like material will as hereinbefore stated be subjected to compression and tension stresses owing to the direction of the wheel loads and the fact that the inner and outer members are of non-circular cross-sectional shape.

As applied to a main undercarriage strut where the wheel loads will be considerably higher than those to which the shock-absorber would be likely to be subjected when used in conjunction with a tailwheel mounting, it is preferred that a plurality of such shock-absorber units such as 1 shall be employed which may be connected together in any suitable manner so that they will share and will be capable of absorbing the higher wheel loads encountered.

In the example shown in Figure 4 the main landing wheel 11 is mounted between fork members 12 which also are preferably arranged in trail, the fork members being bolted or otherwise secured at a point intermediate their length to the inner member, or inner members of the shock-absorber unit or units, 1 at the base of the strut 13 (the shock-absorber units, if more than one is employed, are mounted coaxially). The forwardly-projecting ends of the fork members 12 are connected by a suitable link or links 14 with one or more additional upper shock-absorber units 1 carried by the strut 13 or, alternatively, by its mounting bracket 15. The additional unit or units may, for example, be carried by the usual mounting bracket into which the upper end of the undercarriage strut 13 fits, the inner member 1*a*, or inner members if more than one unit is employed, being fitted with one or more lever arms 16 which are pivotally attached to the upper end or ends of the link or links 14. With this arrangement pivotal movement of the wheel fork parts 12 as a result of a fluctuating wheel load will result in torsional stresses being set up in all the shock-absorber units, angular movement of the wheel fork parts being transmitted by way of the intervening link or links 14 to the lever arm or arms 16 associated with the upper shock-absorber unit or units. For the purpose of accurate adjustment of the two sets of shock-absorber units separated by the intervening link or links 14, the latter may be adjustable in length. Furthermore, it will be appreciated that in such a case the major axis of each shock-absorber unit may be arranged horizontal or substantially horizontal and for that reason it may be found desirable, instead of increasing the thickness of the rubber or like material intermediate the extremities of the inner and outer members (i.e. on the major axis) to increase the thickness of the rubber at the sides of the inner and outer members (i.e. on the minor axis).

Figure 5 shows a further construction of main under carriage unit in which a pair of levers, each supporting a shock-absorbing unit (such as illustrated in Figs. 2 and 3) are connected each to one of the members of its associated unit. The other members of the two units are rigidly connected together and the landing load is applied to at least one of the levers and is transmitted to the two units. For this purpose, the landing wheel 11 is mounted between fork members 12, arranged in trail, which are connected to the inner member 1*a* of a unit 1 the outer member of which is secured in a bracket 17 at the base of the strut or leg 13. This unit is therefore not only placed under torsion by the landing load but also acts as a pivot for the members 12. These latter extend forward as at 12^1 from the unit 1 and support another unit 1^1 being connected to the inner member thereof. Another pair of levers 19 is pivoted to the bracket 17 at 20 and extends forward above the lever members 12^1 and supports an upper unit 1^{11}, being connected to the inner member thereof. These two units 1^1 and 1^{11} which are thus supported by the levers 12^1 and 12 are rigidly connected by a block 18 in

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which their outer members are received. It will therefore be appreciated that the landing load is applied to all three units.

Although it is preferred that the rubber 1*c* shall be bonded to the inner and outer members 1*a*, 1*b* the rubber may for example be inserted under tension, the rubber after insertion being permitted to expand so as to grip the surfaces of the inner and outer metal members.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. Aircraft landing gear incorporating a torsion unit or a shock-absorbing unit comprising two members connected by an intervening layer of elastic material, which layer is deformable under the landing load and thereby permits of relative movements of partial rotation between the two said members.

2. Landing gear according to claim 1, wherein said members comprise an outer member and an inner member housed therein and wherein the elastic material encircles the inner member within the outer member.

3. Aircraft landing gear incorporating a torsion unit or shock-absorbing unit comprising inner and outer members having respectively outer and inner peripheries of non-circular form, and an intervening layer of elastic material.

4. Landing gear according to any of the preceding claims, wherein the said layer is natural or synthetic rubber.

5. Landing gear according to claim 4, wherein said rubber layer is bonded to the two members.

6. Landing gear according to any of the preceding claims, having the unit of substantially oval or elliptical section.

7. Landing gear according to any of the preceding claims, comprising a lever, such for example as a wheel fork or equivalent wheel-carrying lever, connected to one of the members of the unit to apply the load thereto.

8. Landing gear according to any of the preceding claims, comprising a plurality of said units and means, for example lever arms and linkage, connecting them so that the load is applied to them all.

9. Landing gear according to claim 8 having two units spaced apart lengthwise of an undercarriage strut, leg or its equivalent and a link extending lengthwise of the latter to connect them.

10. Landing gear according to any of claims 1—8, comprising a pair of levers each supporting a unit and connected each to one of the members of its associated unit, means rigidly connecting the other members of the units together, and means for applying the landing load to at least one of the levers whereby said load is transmitted to both units.

11. Landing gear according to any of the preceding claims, incorporating a wheel-carrying castor-member operating as a load-applying lever.

12. Aircraft landing gear substantially as described herein with reference to Fig. 1, or Fig. 4, or Fig. 5 of the accompanying drawings.

Dated this 21st day of September, 1945.

ERIC POTTER & CLARKSON,
Chartered Patent Agents,
Eighteen, Park Row, Nottingham.

Reference has been directed in pursuance of Section 7, sub-section (4), of the Patents and Designs Acts, 1907 to 1946, to Specification No. 493,521.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1947.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies, price 1s. 0d. each (inland) 1s. 1d. (abroad) may be obtained.

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583,963 COMPLETE SPECIFICATION

2 SHEETS
SHEET 1

FIG. 1

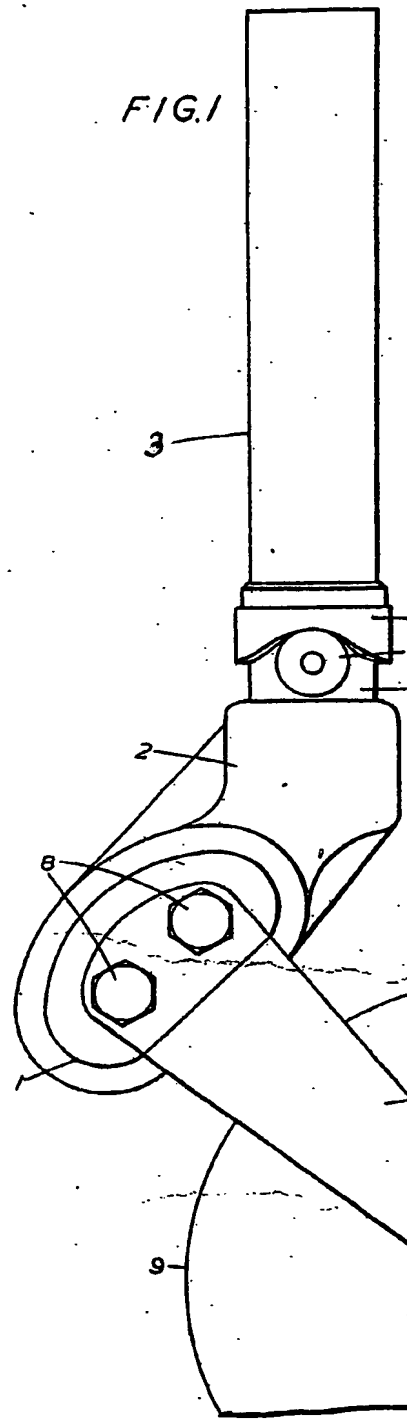
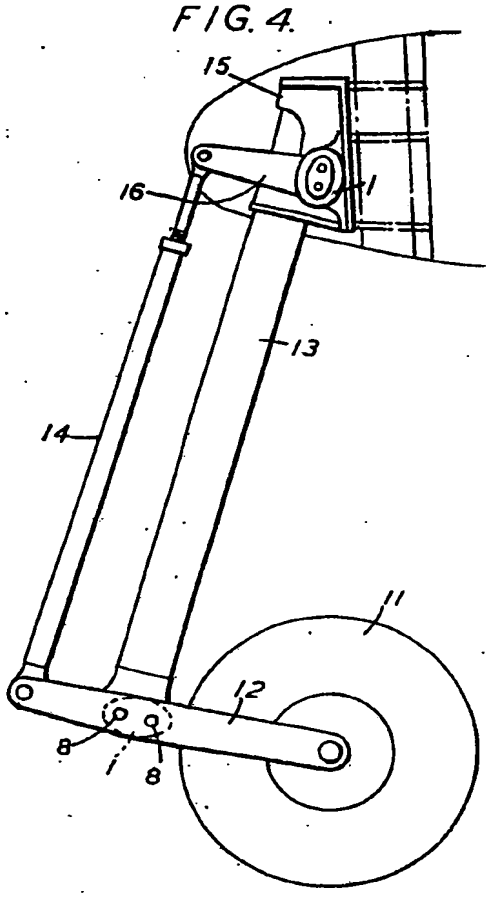


FIG. 4.



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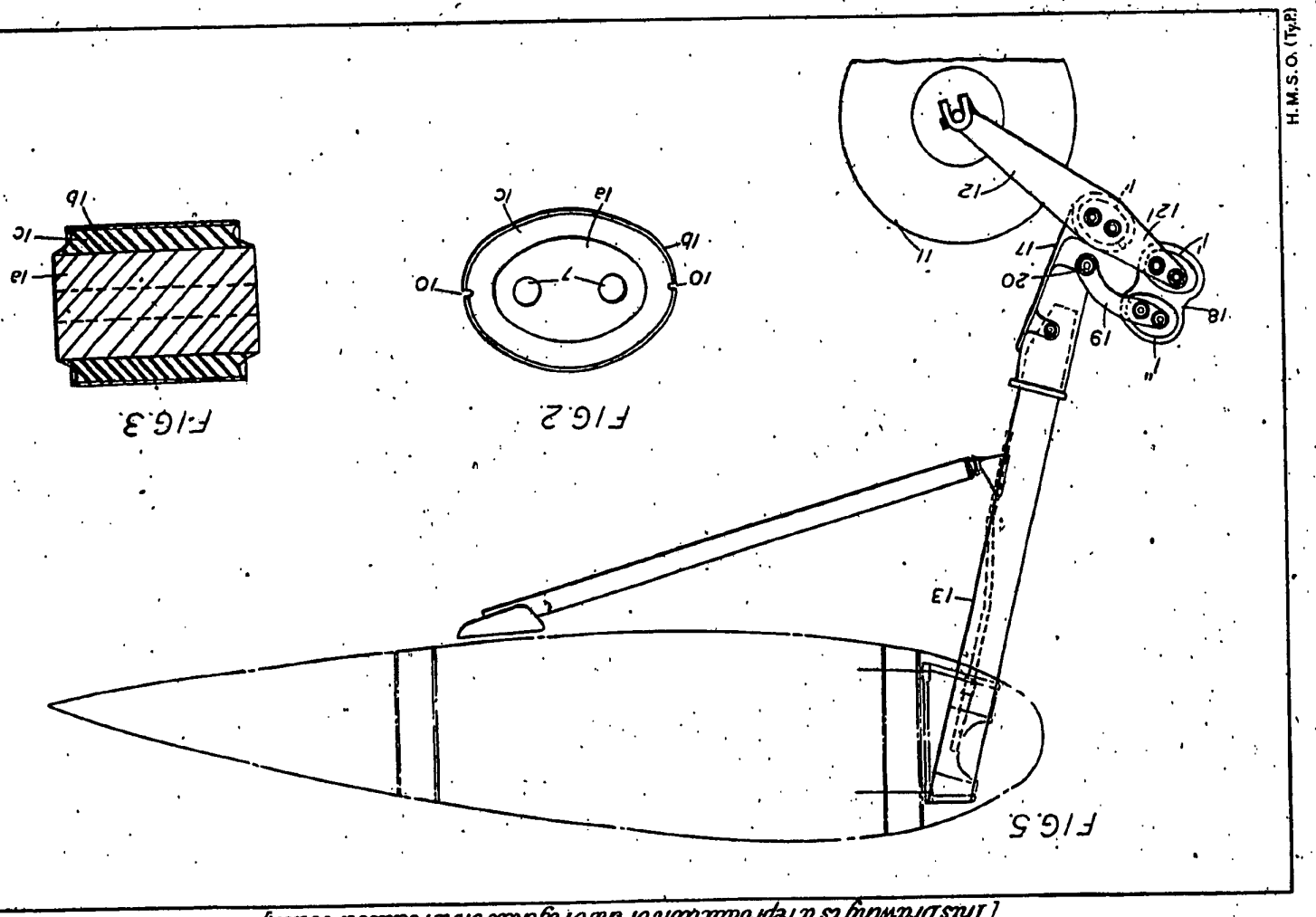
2 SHEETS
SHEET 2



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